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A DURABLE, PLASTIC SOLAR WATER HEATER

Cath Kutay, Martin Anda, Kuruvilla Mathew and Goen Ho
Remote Area Developments Group
Institute for Environmental Science
Murdoch University

In remote areas of Australia the extreme climatic conditions and the high salt content of the water has led to the development of a plastic solar water heater. This system overcomes problems experienced in commercial, metallic units which suffer from blockages, breakages and ruptures due to freezing. The plastic design is also modular and is easy to assemble on site thus reducing transport costs.

INTRODUCTION

In recent years many small family groups of Aboriginal people have been moving away from larger settlements back to their traditional lands to establish semi-sedentary, semi-traditional communities. .A regular and plentiful supply of hot water is necessary for these communities for showering and laundering. Hot water will improve the poor environmental hygiene conditions which give rise to diseases such as trachoma and skin infections. The cost of diesel-powered water heating and the problems of fuel supply to remote areas suggests looking for an alternative to conventional hot water systems. Traditionally local firewood is used, but in semi-permanent communities the demand on such resources in a limited area has a high impact on the semi-arid environment. Solar energy hot water can help reduce this demand on resources.

The Remote Area Developments Group (RADG) in conjunction with the Appropriate Technology Unit at Newman Campus - Hedland College has been developing a new, low-cost solar water heater for remote area Aboriginal communities. At present the low efficiency of the system

CONVENTIONAL SYSTEMS

Conventional solar water heaters are plagued with the following problems in remote communities:

* freezing causes fracture of the copper tubes;
* servicing of cracked tubes or other failed components is not readily available within communities;
* glazing is smashed by rocks;
* there is no electricity to boost supply on overcast days;
* Aboriginal people are not experienced in that type of technology
* the high mineral content of water in remote areas leads to a rapid build-up of deposits in the copper tubes, resisting flow or causing complete blockage;
* the volume of hot water produced is sometimes not sufficient for the needs of the community;
* contractors have sometimes installed the equipment incorrectly.

The high amount of sun shine in north and central Australia supports attempts to provide hot water with a reliable and passive (ie no pump) solar unit. Commercial units have tried to overcome freezing with the use of glycol (anti-freeze) in the water of the solar heater. Then the water used is passed in pipes through the tank of glycol water to absorb its heat To reduce the likelihood of rocks smashing the cover, hardened or tempered glass can be used. To prevent carbonate minerals from the water depositing and blocking pipes (calcification), new devices have been developed which use electric or magnetic action to extract these minerals from the water before the inlet to the heater. Each of these modifications add cost and complexity to the device.

The system being designed by the RADG will overcome the problems which were listed above by cheaper and more appropriate means.

Due to the lack of power in communities, a pump cannot be used to circulate water in the heater. The solar water heater operates on the 'thermosyphon effect', in other words, by natural convection or flow of water through the pipes through heating by the sun. The water is heated in the pipes, so flows up to the top of the tank. The cold outlet from the bottom of the tank replaces the water in the collector with cold water.

Plastic components are used which do not crack when frozen and tend to block less from mineral buildup. Plastic solar water heaters have been developed already in the past, but mostly for heating swiming pools. For domestic water heating, one unit has been designed, tested and manufactured here in Perth, called "Solco". If this unit was left in the sun up north without water in it, it would probably melt. A West German company manufactures a very good plastic solar water heater design although it is very expensive to import to Australia. All these systems will be tried for durability and supply or sufficient water in communities.

The solar system can be glazed using clear plastic sheeting which is harder to break. When the collector panel is glazed the heat absorbed by the plastic tubes is collected by the water passing though the collector instead of being re-radiated back to the air. This is the 'greenhouse effect'. Some plastic collectors should not be fully covered in glass (or plastic) sheets as they can possibly melt and become damaged in intense sun shine. Other, more expensive plastics, have been treated to enable them to withstand these higher temperatures.

DESIGN

To reduce costs further it is proposed that the design use plastic products that are already available for other uses, such as pool heaters or reticulation systems. It is not necessarily appropriate to use second-hand components in this application because the unit is designed to be made in quantity.

Because it is difficult to design plastics to hold hot water at high pressure, the present system uses a "header tank" which is a small plastic storage tank placed on top of the storage tank. The cold water first enters this tank, possibly under mains pressure. A float valve like those used in toilet cisterns is used to stop further water entering when the header tank is full. The water then flows from this tank through the collctor to be heater. The amount of pressure the water leaves the solar water heater is related to how high the "header tank" is above the ground, that is, how much "head of water" there is. This pressure is not great, so the water comes out fairly slowly.

The storage tank is plastic also to avoid corrosion. This is insulated with fibreglass or polystyrene plastic to store the heat overnight or for some time in cold or overcast weather. A 200-litre storage volume was found to be sufficient for showering and washing clothes of 4-5 people, although a 300-litre tank may be more appropriate as usually more people will be using the facility. A fairly common type of plastic drum can store water only up to 60°C before it begins to warp. A plastic drum however is rather awkward to build and transport. A new tank has been designed using a bladder like a wine cask. The bladder is supported on the outside by a metal casing insulated with polystyrene.

TESTING

Several prototypes are being developed and tested by the group. In each case the collector panels are made from black plastic. One collector type uses tubing - either garden reticulation tubing which can be heated up to 40° or higher temperature plastic which can be heated to 90° and hence can be glazed. Another uses strips of joined tubes used in pool heating. The latest prototype system has been placed in Peppertree Camp, near Kalgoorlie.

Testing in different parts of Western Australia helps the group find out the performance of different collectors. The tank temperatures achieved in September in Perth were typically 40°C while in Newman they were 50°C. The body comfort temperature for showering is typically around 38°C so better performance is necessary especially to achieve hot water in winter. Factors which effect the amount of hot water the system can produce, and how hot the water is, is influenced by :

* the amount of sunshine on the collector
* the amount of heat absorbed by the tubes and the amount re-emitted back into the air
* the amount of heat transfered to the water inside the tubes before it is lost to the air
* the heat loss though wind on the collector and the outside air temperature

* heat loss from the storage tank.

CONSTRUCTION

The solar water heater collector and tank systems have been designed to be constructed on site, from kit form. Thus it can be constructed in a community workshop as part of the Remote Area Hygiene Facility. As for the RAHF, construction of the solar heater by the community should encourage maintenace by the community and enable them to replace parts when breakage or deterioration occurs. Also this technique of construction should avoid the problem when contractors install units incorrectly and disappear.

The whole tank is collapsible so that it can be transported to remote locations or in bulk overseas without taking up as much volume as a normal empty drum. This reduces cost on the unit. Such a unit which produces higher temperatures, and preferably operates on higher pressures, will be suitable for sale in South East Asia as well as mining and pastoral communities of Australia.

FUTURE DEVELOPMENTS

Further work is being done to develop a unit which will provide much higher temperature water and work on mains pressure water. One difficulty with many plastic constructions is that they cannot be used with hot water under pressure. The new design aims to provide high pressure hot water, in places where the water pressure is high. The first step is to use higher temperature plastics, welded together. Then such a system could be fully glazed, thus increasing efficiency. For areas with very high radiation, a temperature variant glazing is being developed, based on window louvres.

The new design will be developed so that the solar water heaters can be manufactured easily by small, Aboriginal enterprises that will supply equipment to establishing communities and possibly to existing community where solar heters have failed. It is hoped the solar water heater will retail at around $1,200 to $900 for the higher temperature system. The unit will then be attractive to all people living in rural areas.

CONCLUSION

Designing for durability, low cost and modular form is possible and the first prototypes have shown good performance results. Durability of the units is still to be tested and further improvements in poerformance could be achieved. With a unit producing above 57 degree water most of the year, the system will be saleable to remote communities in Australia and overseas.

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